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Development of nutritionally enriched instant weaning food and its safety aspects

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Malnutrition is persisting among children in Bangladesh due to lack of proper weaning foods. A highly nutritive instant weaning food was prepared in our laboratory by using locally available food resources with the aim to ensure the availability of low cost weaning food in Bangladesh. The developed food was evaluated for their nutritional characteristics and microbiological quality. The food contained the major nutrients like moisture, ash, fat, protein, fiber, carbohydrate and energy 2.43%, 2.26%, 11.32%, 15.98%, 1.06%, 75.35% and 456.6 kcal/ 100 g, respectively which were comparable to those of the three good quality imported commercial weaning foods F-1, F-2 and F-3. The vitamin A, iron and calcium contents were significantly different (p<0.05) than the commercial foods. The highest protein efficiency ratio and feed efficiency ratio were shown in the rats feed on the prepared weaning food than the imported commercial weaning foods. The overall bacteriological status of the prepared and the imported commercial weaning foods were observed to be satisfactory. The costs of the developed weaning food is considerably cheaper than the three imported commercial weaning foods of same quality and suitable for low income people of Bangladesh.

Key words: Instant, low cost, weaning food, cereals, rice.

INTRODUCTION

Inappropriate feeding practices of infant and young children are the most serious obstacles to maintaining adequate nutritional status and contribute to levels of malnutrition in Bangladesh that are amongst the highest in the world. Poverty, malnutrition and disease are inter-linked with each other. Malnutrition in children is the con-sequence of a range of factors, which are often related to poor food quality, insufficient food intake, severe and repeated infectious diseases; or frequently it involves some combination of the three (deOnis et al., 1993). According to Institute of Public Health and Nutrition (IPHN), Bangladesh (2007), almost one-half of children under five years are underweight and 42% are stunted. Only 42% of infants aged less than six months are exclusively breastfed and almost one-third (29%) of children aged 6 to 9 months do not receive any solid or semi-solid foods. The most common complementary foods include khichuri, bhaat dal, suji and muri (IPHN, 2007).

The introduction of supplementation in terms of weaning foods prepared from easily available and low cost ingre-dients is of vital importance to meet the require-ments of the growing children (Saeeda et al., 2009). In most deve-loping countries, commercial weaning foods of excellent

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quality either imported or locally produced are generally 10 to 15 times higher than the cost of the common staple foods due to sophisticate processing, expensive packing, extensive promotion and solid profit margins (Bahlol et al., 2007). Therefore, development of supplementary foods based on locally available cereals and legumes has been suggested by the Integrated Child Development Scheme (ICDS) and Food and Agriculture Organization (FAO) to combat malnutrition among mothers and children of low socio-economic groups (Imtiaz et al., 2011).

Rice alone constitutes 92% of the total food grains produced annually in Bangladesh. It provides about 80% of the people's energy intake, the majority of their protein intake, and a considerable proportion of several micro-nutrients in their average daily diet (Provash and Mahendran, 2012). At present, there are no instant weaning foods manufactured in Bangladesh from locally available food resources and all the weaning foods available in the local markets are imported commercially (Imtiaz et al., 2011). Bangladesh is a very densely populated poor country. Hence, these imported commercial foods are too expensive for low income families. Thus, in this study, a cereal based weaning food is prepared to ensure the availability of low cost weaning food which is microbiologically safe to reduce malnutrition and mortality rate in infants. We also compare the nutritive value of the prepared weaning food with the available imported commercial weaning foods in Bangladesh.

MATERIALS AND METHODS

Collection of imported commercial weaning foods and raw materials

The three imported commercial weaning foods (Cerelac wheat – milk as F-1, Cerelac rice- milk as F-2 and Biomil rice-milk as F-3) were selected on the basis of its popularity and market availability. F-1 and F-2 both are marketed by Nestle Bangladesh Limited. F-3 is marketed by Fasska Food Industries Limited, Bangladesh. These three commercial weaning foods are recommended for children aged 6 months and above. These weaning foods were purchased from the super markets in Dhaka, Bangladesh.

Rice, sugar, skim milk powder, butter etc. were purchased from a local market in Dhaka city, Bangladesh and transported to the laboratory in clean polyethylene bags for later use.

Processing of rice

Rice powder was blended with enzyme and incubated at 70°C for 90 min with occasional stirring. Emulsifier was blended and mixed again with the butter thoroughly. The mass was then passed through the roller dryer to make flakes. The white flakes were grounded and passed through 1 µm mesh sieve.

Nutritional criteria for developing instant weaning food

The weaning food was developed taking into consideration the:

i) Codex Alimentarius Standards for foods for special dietary uses (including foods for infants and children) (WHO, 1994).
ii) Recommended daily allowances (RDA) for energy, protein and other nutrients for 7 to 12 months old infant by Food and Nutrition, Institute of Medicine (IOM, 2005).

Formulation of instant weaning food

Rice flakes, skim milk powder, butter, vitamin premix and sugar were blended for the preparation of weaning food. The complete processing steps of weaning food are shown in Figure 1.

Chemical analysis of weaning foods

Nutrient analysis

The nutrient compositions of the imported commercial weaning foods and as well as the prepared weaning food that is prepared in our laboratory were carried out as follows:

Determination of moisture content: Moisture content was determined by oven-dry method as the loss in weight due to evaporation from sample at a temperature of 105°C. The weight loss in each case represented the amount of moisture present in the sample:

$$\text{Moisture (\%)} = \frac{\text{Weight of original sample} - \text{weight of dried sample}}{\text{Weight of original sample}} \times 100$$

Determination of crude protein: The crude protein content was determined following the micro Kjeldahl method (AOAC, 2005). Percentage of nitrogen (N) was calculated using the following equation:

$$\text{Nitrogen (\%)} = \frac{(S-B) \times N \times 0.014 \times D}{W \times V} \times 100$$

Where D = Dilution factor, T = titre value = (S-B), W = weight of sample, 0.014 = constant value.

Crude protein was obtained by multiplying the corresponding total nitrogen content by a conventional factor of 6.25. Thus, crude protein (%) = % of N × 6.25.

Determination of crude fat: Crude fat was determined by the soxhlet extraction technique followed by AOAC (2005). Fat content of the dried samples was easily extracted into organic solvent (petroleum ether) at 60 to 80°C and followed to reflux for 6 h. Percentage of fat content was calculated using the following formula:

$$\text{Crude fat (\%)} = \frac{\text{Weight of fat in sample}}{\text{Weight of dry sample}} \times 100$$

Determination of ash: Ash content was determined by combusting the samples in a muffle furnace at 600°C for 8 h according to the method of AOAC (2005):

$$\text{Ash content (\%)} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

Determination of crude fiber: The bulk of roughage in food is referred to as the fiber and is called crude fiber. Milled sample was dried, defatted with ethanol acetone mixture and then the experiment

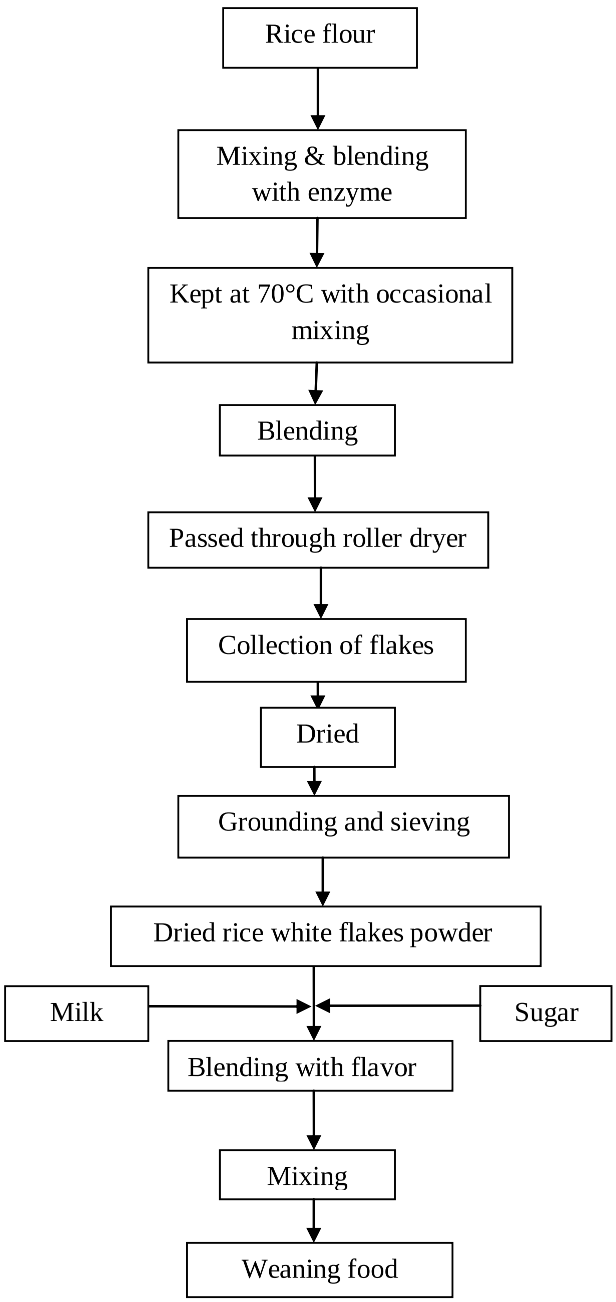

Figure 1. Flow diagram of weaning food formulation from rice, skimmed milk powder and sugar.

was carried out using the standard method as described in AOAC (2005):

$$\text{Crude fiber (\%)} = \frac{\text{Weight of residue} - \text{Weight of ash}}{\text{Weight of sample}} \times 100$$

Determination of carbohydrate: The carbohydrate content was estimated by the difference method. It was calculated by subtracting the sum of percentage of moisture, fat, protein and ash contents from 100% according to AOAC (2005):

Carbohydrate (%) = 100 – (moisture% + fat% + protein% + ash%)

Determination of total energy: The total energy value of the food formulation was calculated according to the method of Mahgoub (1999) using the formula as shown in the following equation:

Total energy (kcal/100 g) = [(% available carbohydrates × 4) + (% protein × 4) + (% fat × 9)]

Determination of vitamin A: About 10 g of sample was homogenized, weighed and transferred into a ground bottom flask, 30 ml of extraction solution, 0.1% antioxidant and few drops of KOH were added and reflux for 30 min at 70°C. The sample was cool down, vitamin A was extracted into hexane, and the combined hexane extract was washed with water and then dried the hexane layer to about 2 ml on a water bath or rotary evaporator. The final volume was made up to 50 ml with the mobile phase. The mobile phase, standard and sample were filtered through 0.45 µ membrane filter and were degassed before injection. Calibration curve was made by a standard in mobile phase with five point calibrations and analyzed independently by HPLC. A standard curve was plotted between the concentration of vitamin A and peak area obtained. For HPLC analysis, an Eelipse × BD – C_{18} column (4.6 × 250 mm 5 µm) was used with a linear gradient of methanol: water (95:5) at constant flow rate of 1 ml /min by using a binary pump with column temperature 40°C. A multiple wavelength detector was employed for the detection of pecks using a wavelength of 325 nm and a bandwidth of 8 nm.

Determination of minerals: The mineral contents were determined after the ash content determination. The ash residue of each formulation was digested with perchloric acid and nitric acid (1:4) solution. The samples were left to cool and contents were filtered through Whatman filter paper 42. Each sample solution was made up to a final volume of 25 ml with distilled water. The aliquot was used separately to determine the mineral contents of Fe and Ca by using an Atomic Absorption Spectrometer (Spectra AA 220, USA Varian).

Determination of amino acids: Amino acid composition of samples was measured on hydrolysates using an amino acid analyzer based on HPLC system. Sample hydrolysates were prepared following the method of Moore and Sterin (1963).

Determination of microorganism: Microbiological examination of the weaning foods was performed to assess bacterial, fungal and yeast load under laboratory condition. Standard Plate Count (SPC), fungal and yeast count and enumeration of total coliform and *Salmonella* of the weaning foods were examined according to BAM (1998). Plate count method was employed for the examination of total number of viable microbes present in the sample. Standard plate count (SPC) was estimated by decimal dilution technique followed by pour plate method and spread method for fungus and yeast. Streak plate method was used to isolate the specific microorganism. Isolation and enumeration of total coliform were performed by most probable number (MPN) method using MacConkey broth (Harrigen and MacCance, 1976).

Rat bioassay

To assess the nutritional quality of the weaning foods, a standard rat bioassay procedure was done in the animal house section, Institute of Food Science and Technology (IFST), BCSIR, Dhaka. Long-Evan (28 to 30) days old rats were used to study the growth after feeding of the specific weaning foods. The rats were divided into four groups containing 4 to 5 male rats in each cage, main-

Table 1. Nutritive Value of the Prepared Weaning Food as compared with Imported Commercial Weaning Foods

Nutrient	Prepared weaning food	F1	F2	F3
Moisture (%)	2.43 ± 0.076[a]	3.35±0.33[b]	2.79 ± 0.26[ac]	3.85 ± 0.30[d]
Protein (%)	15.98 ± 0.48[a]	14.42 ± 0.33[b]	13.79 ± 0.22[bc]	13.00 ± 0.45[cd]
Fat (%)	11.32 ± 0.25[a]	8.08 ± 0.38[b]	10.16 ± 0.36[c]	6.78 ± 0.28[d]
Carbohydrate (%)	75.35 ± 0.61[a]	66.60 ± 0.65[b]	69.56 ± 0.94[c]	64.43±0.52[d]
Ash (%)	2.26 ± 0.35[a]	3.15 ± 0.10[b]	2.85 ± 0.20[ac]	2.33 ± 0.48[ac]
Fiber (%)	1.06 ± 0.08[a]	2.31 ± 0.25[b]	1.89 ± 0.21[bc]	1.55 ± 0.28[ac]
Energy(kcal/100 g)	456.67 ± 7.64[a]	423.33 ± 10.40[b]	427.67 ±11.24[bc]	391.33 ± 3.21[d]
Vitamin A (µg/100 g)	289 ± 3.60[a]	260 ± 5.00[b]	257.67 ± 2.57[bc]	241.67 ± 7.64[d]
Vitamin B1 (mg/100 g)	0.55 ± 0.03[a]	0.67 ± 0.03[b]	0.59 ± 0.03[ac]	0.42±0.04[d]
Iron(mg/100 g)	7.32 ±0.24[a]	7.57 ± 0.18[a]	7.46 ± 0.37[a]	6.58 ± 0.19[b]
Calcium (mg/100 g)	446.00 ± 5.29[a]	330.00 ± 5.00[b]	436.67 ± 2.89[ac]	495.00 ± 5.00[d]

Mean values by different superscripts within columns are significantly different at ($p<0.05$).

tained at room temperature with 12 h light/dark cycle. They were subjected to a 7 days acclimatization period and the individual groups were given same amount of commercial laboratory chow diet. After 7 days, each rat group acclimatized on average 55 g of different weaning foods and was feed water *ad labitum* for 4 weeks. The control group was feed on casein diet containing 75% starch, 10% oil, 4% salt, 1% vitamin mix and 10% casein protein. Food consumption, spoilage and weight gain were recorded in every 4 days. Protein efficiency ratio (PER) and feed efficiency ratio (FER) was calculated using the following formula:

$$\text{PER} = \frac{\text{Weight gain of test group (g)}}{\text{Total protein consumed (g)}}$$

$$\text{FER} = \frac{\text{Gain in body weight (g)}}{\text{Food consumed (g)}}$$

Estimation of cost

The cost of developed weaning food was determined according to the price of the materials used in preparing the food, gas, electricity, jars, water and others. The cost of the prepared food was compared with market price of the three imported commercial baby foods at the same time.

Statistical analysis

The data were analyzed using SPSS version 17.0. The mean and standard deviations of the triplicate analyses were calculated. The analysis of variance (ANOVA) was performed to determine significant differences between the means using Dunnett's T3 tests.

RESULTS AND DISCUSSION

Nutritional composition

The nutritional compositions (g/100 g dry weight) of the prepared weaning food and imported commercial weaning foods were summarized in Table 1. The energy content of the prepared weaning food was 456.67 kcal/100 g. For the imported commercial weaning foods, the energy content ranged from 391.33 to 427.67 kcal/100 g which was significantly lower than the prepared weaning food. For all the weaning foods both prepared and commercial, the energy density per 100 g of the dry food was lower than the minimum energy (483.9 kcal/100 g) recommended in the Codex Alimentarius Standards for weaning/follow up foods (FAO/WHO, 1994). Protein is one of the most important nutrients required in weaning foods. The prepared weaning food had a protein content of 15.98% which was higher than the minimum amount (14.52%) specified in Codex Alimentarius standards. The protein levels of the commercial weaning foods ranged from 13.00 to 14.42% which were significantly lower than the prepared weaning food and slightly below the Codex Alimentarius standards lower limit. According to FAO/WHO Codex Alimentarius Standards for follow – up/ weaning foods, the protein content should range from 14.52 to 37.70 g/100 g (FAO/WHO, 1994). The prepared weaning food contained 11.32% of fat which was significantly higher ($p<0.05$) than the commercial weaning foods ranged from 6.78 to 10.16% but lower than the specified amount in the Codex Alimentarius Standards (range 14.52- to 41.13%). For the commercial weaning foods, F-2 had a fat content of 10.16% which is significantly higher ($p<0.05$) than the F-1 and F-3.

The lower fat content had contributed to lower energy value of the prepared weaning food. The lower fat content may also have contributed to the increase in the shelf - life of the formulation by decreasing the chances of rancidity (Onuorach and Akijede, 2004). Ash content is an important nutritional indicator of mineral content and an important quality parameter for contamination, particularly with foreign matter (for example, pebbles) (Fennema, 1996). The ash content of the prepared weaning food was 2.26%; this result was significantly lower than F-1 which contained 3.15% (Table 1); but the ash content of the prepared food was comparatively within the same range as that of F-2 (2.85%) and F-3 (2.33%). No standard for ash concentration has been specified for weaning/follow–up foods in the Codex Alimentarius Standards (FAO/WHO, 1994). The moisture content of the prepared weaning food was 2.43%. This result was significantly different from the commercial weaning foods F-1 and F-3 which were 3.35% and 3.85%, respectively (Table 1). The commercial weaning food F-2 contained 2.79% moisture which has no significant difference from the prepared food. The percent crude fiber of the prepared weaning food was 1.06 (Table 1). This value was significantly lower than the value of commercial weaning foods which ranged from 1.55 to 2.31%. Low fiber concentration in the prepared weaning food could be due to use of highly refined rice flours.

Fiber is an important dietary component in preventing overweight, constipation, cardiovascular disease, and diabetes and colon cancer (Mosha et al., 2000). High dietary fiber content has been reported to impair protein and mineral digestion and absorption in human subjects (Whitney et al., 1990). Some fiber related fractions such as polyphenols and non-starch polysaccharides, bind minerals such as Ca, Zn and Fe, making them unavailable for human nutrition (Fairweather-Tait and Hurrell, 1996). The carbohydrate content in the prepared weaning food was 75.35% (Table 1). This result was significantly ($p<0.05$) higher than the commercial weaning foods which ranged from 64.43 to 66.60%. The carbohydrate levels of the prepared weaning food and all the imported commercial weaning foods were higher than the lower limit (41.13 to 73.79 g/100 g) of the Codex Alimentarius Standards (FAO/WHO, 1994). Vitamins are substances which are indispensible for the growth and maintenance of good health. According to Codex Alimentarius Standards (FAO/WHO, 1994), the recommended levels (µg/100 kcal) of vitamin A for processed cereal based foods for infants and young children ranged from 60 to 180 µg/100 kcal. On comparing with this standard, the prepared weaning food had vitamin A content of 63.28 µg/100 kcal and the imported commercial weaning foods F-1, F-2, and F-3 had vitamin A content of 61.42, 60.25 and 61.76 µg/100 kcal, respectively which were above the minimum limit (60 µg/100 kcal) specified in the Codex Alimentarius standards. The vitamin A content of the prepared weaning food was significantly higher ($p<0.05$) than the commercial weaning foods (Table 1).

The prepared weaning food had vitamin B1 content of 120.44 µg/100 kcal (Table 1). For the imported commercial weaning foods, F-1, F-2 and F-3 had vitamin B1 content of 158.27, 137.96 and 107.33 µg/100 kcal, respectively. The vitamin B1 contents of the locally prepared weaning food and the commercial weaning foods were higher than the minimum amount (60 µg/100 kcal) specified in the Codex Alimentarius Standards (FAO/WHO, 1994). Calcium is an essential element in infants and young children for building bones and teeth, functioning of muscles and nerves, blood clotting and for immune defense (Whitney et al., 1990). The concentration of Ca of the prepared weaning food was 446.0 mg/100 g which was significantly different from the imported commercial weaning foods F-1 and F-3 by 330.00 and 495.00 mg/100 g, respectively (Table 1). According to the Codex Alimentarius standards, Ca concentrations in weaning foods should not be less than 435.51 mg/100 g of the dry food. On the basis of this standard, the prepared weaning food and all the imported products, except F-1 had the Ca concentrations above the minimum amount (435.51 mg/100 g) specified in the Codex Alimentarius Standards (FAO/WHO, 1994). Iron is an essential micronutrient for the synthesis of hemoglobin (an oxygen carrier in the red blood cells), myoglobin (used for muscle contraction) and enzymes/coenzymes (used in various metabolic pathways). Iron also enhances the body's immune system thus, reducing infections and fostering proper functioning of other organs of the body (Whitney et al., 1990).

Iron concentrations in the prepared weaning foods were 7.32 mg/100 g (Table 1); while in the imported commercial weaning foods, the concentration ranged between 6.50 to 7.57 mg/100 g. The prepared weaning food and all the imported products had the iron concentrations above the minimum amount (4.8 mg/100 g) specified in the Codex Alimentarius Standards (FAO/WHO, 1994). According to Food and Nutrition, Institute of Medicine (IOM, 2005), the recommended daily allowances (RDA) for energy, carbohydrate, protein, fat, vitamin A, vitamin B1, Ca and Fe for 7 to 12 months old infant are 743 kcal, 95 g, 11 g, 30 g, 500 µg, 0.3 mg, 270 mg and 11 mg, respectively. A 100 g portion of prepared weaning food assayed in this study could meet the daily requirements (% of RDA) of energy (61.46%), carbohydrate (79.32%), protein (145.27%), fat (37.67%), vitamin A (57.8%), vitamin B1 (183.33%), Ca (165.19%) and Fe (66.55%). For the imported commercial weaning foods, a 100 g portion of the food could meet the daily requirements (% of RDA) of energy (52.67 to 56.98%), carbohydrate (67.82 to 73.22%), protein (118.18 to 131.09%), fat (22.60 to 33.87%), vitamin A (48.33 to 52.00%), vitamin B1 (140.0 to 223.33%), Ca (122.22 to 183.33%) and Fe (59.82 to 68.82%).

These findings suggest that, both prepared and commercial weaning foods have the potential to provide the recommended daily requirements for energy and other nutrients for infants and young children. These foods, however, may be unable to meet the RDAs for energy and macro/micronutrients as the children grow older due to increased demand for nutrients to support growth.

Quality evaluation

In a well - balanced weaning food, 13% of the total energy is usually derived from protein, 26% from fat and 61% from carbohydrates, respectively (Royal Tropical Institute, Amsterdam Weaning Food, 1987). The pre-

Table 2. Percent calories from different nutrients of weaning foods

Weaning foods	Percent calories		
	Protein	Carbohydrate	Fat
Prepared food	14.00	66.00	22.30
F-1	13.63	62.93	17.18
F-2	12.89	65.05	21.38
F-3	13.29	65.85	15.41

% Protein calories = Protein% X 4/ Total energy of formulations; % Carbohydrate calories = Carbohydrate % X 4/ Total energy of formulations; % Fat calories = Fat % X 9 / Total energy of formulations

Table 3. Amino acids composition (g/100g crude protein) of the prepared weaning food and percentage of RDA of amino acids met per 100g of prepared weaning food.

Amino acid	Prepared food	*RDA	% of RDA met
Aspartic Acid	0.62	-	-
Threonine	0.42	2.6	16
Serine	0.54	-	-
Glutamic Acid	1.43	-	-
Glycine	0.43	-	-
Alanine	0.94	-	-
Valine	0.30	4.2	7
Methionine	0.54	2.2	24
Isoleucine	0.96	4.2	22
Leucine	0.20	4.8	4
Tyrosine	0.60	-	-
Lysine	1.34	4.2	31
Arginine	1.31	2.0	65

* Source of RDA: FAO/WHO (1973).

pared weaning food had higher concentration of calories from carbohydrate and protein than the recommended values (Table 2). The prepared weaning food and the imported commercial weaning foods F-1, F-2, F-3 provided 22.30 and 17.18, 21.38 and 15.41% of the total calories from fat, indicating low energy density in these baby foods. Such an imbalance of calories from different nutrients may affect the quality of the diet (Khan, 1989).

Amino acid composition

The amino acid compositions of the prepared weaning food were shown in Table 3. The results showed that the prepared weaning food contained thirteen amino acids including seven essential amino acids. The percentage of recommended dietary allowance (RDA) of essential amino acids of the prepared food was also shown in Table 3. The results showed that the prepared weaning food met 16, 7, 24, 22, 4, 31 and 65% of the RDA of essential amino acids which was threonine, valine, methionine, isoleucine, leucine, lysine and arginine, respectively. The low percentage of the essential amino acids of the prepared weaning food compared with the RDA of essential amino acids for children could be ascribed to the fact that the weaning food was prepared from plant based food materials (rice). A number of studies have shown that the protein content of plant- based food materials is inadequate to meet the protein requirements of individuals compared with food material produced from animal sources (Ijarotimi and Olopade, 2009).

Microbiological quality of weaning foods

The overall bacteriological status of the prepared and the imported commercial weaning foods was observed to be satisfactory (Table 4). The obtained results revealed that the total viable bacterial count, total yeast and mold count, total coliform count and presence of *Salmonella* per gram were absolutely nil/g in the all weaning foods analyzed, when packets were opened. The low counts of the examined foods indicated adequate thermal process, good quality of raw materials and as a result of the good

Table 4. Comparative Microbiological Load of Weaning Foods

Baby food sample	Total viable count (CFU/g)	Yeast and mold count (CFU/g)	Total Coliform count (CFU/g)	*Salmonella*/g
Prepared food	Less than 10	Less than 10	Nil	Nil
F-1	Nil	Nil	Nil	Nil
F-2	Nil	Nil	Nil	Nil
F-3	Nil	Nil	Nil	Nil

Table 5. Food intake, protein intake and body weight gain of rats, for assessment of PER and FER

Weaning foods	Food intake (g)	Protein intake (g)	Weight gain up (g)	PER	FER
Casein diet	545.6	53.05	90.50	1.71	0.17
Prepared food	640.33	62.05	130.65	2.11	0.20
F-1	615.45	60.99	115.56	1.89	0.19
F-2	620.65	61.65	105.60	1.71	0.17
F-3	555.5	55.55	98.65	1.78	0.18

Table 6. Cost of prepared weaning food and imported commercial weaning foods

Cost/ year (900000 packets)	Developed weaning food	F-1	F-2	F-3
Raw materials	71963256 BDT	-	-	-
Manpower	1,159,500 BDT	-	-	-
Utilities	210,000 BDT	-	-	-
Depreciation and other expenditures	1003600 BDT	-	-	-
Other financial expenses	10000000 BDT	-	-	-
Revenue from sales	152019984 BDT	-	-	-
*Price per packet (500g/packet)	263 BDT	350 BDT	385 BDT	450 BDT

*1USD= 77.88 BDT; BDT= Bangladesh Taka; USD= United States Dollar.

different processing conditions under which the production of foods was carried out.

Nutritional quality of weaning foods

In a 21-days study of food intake, the prepared weaning food had the highest value (640.33 g per rat) and it differed from other foods where food intake ranged from 545.6 to 620.65 g per rat (Table 5). Group of rats feed on the prepared weaning food gained the highest body weight (130.65 g per rat) than the other groups of rats feed on the three imported commercial weaning foods where body weight gain ranged from 98.65 to 115.56 g per rat. Also, protein intake was high in the rats feed on of the prepared weaning food. PER and FER were the highest for those rats feed on the prepared weaning food (2.11 and 0.2). The PER of commercial weaning foods were ranged from 1.71 to 1.89 which were similar to casein diet. The imported commercial weaning foods F-1, F-2 and F-3 had 0.19, 0.17 and 0.18 of FER, respectively; and were lower than the prepared weaning food but similar to casein diet. PER was high in the prepared weaning food than the other imported commercial weaning foods (Table 5). So the growth rate was also higher of those rats feed on the prepared weaning food than those rats feed on the commercial foods. Based on earlier studies, it has been recommended that the PER of the weaning foods should not be less than 2.1 and preferably 2.3 (PAG, 1971). Thus, the prepared weaning foods would meet the required standards for PER and adequately satisfied the recommended nutritional quality.

Cost of weaning foods

The cost of the developed weaning food and other commercial products (F-1, F-2 and F-3) were calculated as shown in Table 6. The cost of the prepared weaning food is suitable for the low national income in Bangladesh and cheaper than those of commercial foods.

Conclusion

A highly nutritive weaning food prepared from rice and milk in Cereal Technology section, IFST, BCSIR, Dhaka and safety aspects of it was compared to imported commercial weaning foods. From the nutritional analysis in various constituents like moisture, protein, fat, ash, carbohydrate, crude fiber and energy among four (one prepared and three commercial) weaning foods; the prepared weaning food has shown the most satisfactory result. The protein (an essential nutrient for rapid growth in infants) was highest in the prepared weaning food than imported commercial weaning foods. From the vitamins (vitamin-A and -B1) and minerals (iron and calcium) analysis of those weaning foods, prepared weaning food has also given the most satisfactory result. From the microbial point of view, the prepared weaning food showed satisfactory results with regards to microbial food safety. In rat bioassay, the highest PER and FER were shown in the rats feed on the prepared instant weaning food. Thus, the highly nutritive low cost instant weaning food in our laboratory was satisfactory to meet food safety requirement, ensure the rapid growth of infants and finally, help to reduce malnutrition situation and give extra support to nourishment for the children of Bangladesh.

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